ARS 44-37
September 1958

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

Developments in Improved Livestock Nutrition 1/

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The compilation and publication of comprehensive nutritional requirement data for the various classes of livestock was undertaken in the United States during World War II. This work has been done by committees composed of animal nutrition specialists under the auspices of the National Research Council. With publication of additional new information, revisions have been made. Within the past three years, such revisions have been published for dairy cattle and sheep. Similar revisions for beef cattle, poultry, and swine are expected to be published within the current calendar year. All of these reflect the latest information on nutrient requirements for energy, protein, amino acids, mineral elements, vitamins, and other factors. The standards are much used by students, teachers, extension workers, feed manufacturers, and animal feeders.

Considerable progress has been made in improving methods for the nutritive evaluation of feeds. This is especially true for pastures and harvested forages as used by ruminants. Numerous groups of State experiment station and Federal workers have contributed new information on rumen digestion and on ratio or marker technics. The Ohio Agricultural Experiment Station has been especially active in artificial rumen studies as an alternative to the more cumbersome and time-consuming digestion trial method. The artificial rumen procedure involves the laboratory digestion of forage and feed samples with rumen fluid. Excellent agreement in values for cellulose digestion are being obtained between the two methods on forages.

Other workers have continued their efforts to develop better methods for determining dry matter intake and the digestibility of pasture by grazing animals through the use of ratio technics. This is accomplished through the feeding of definite quantities of inert material such as chromium oxide and analysis of "grab" samples of feces for the inert material and plant pigments or chromogens. In some cases, total collections of feces by means of harnesses with collection bags have been used either for comparative purposes or as the primary procedure.

1/ Paper presented by N. R. Ellis at the Fourth Inter-American Meeting on Livestock Production held July 1958 at Kingston, Jamaica, B. W. I.

In addition to the pasture evaluation, considerable attention continues to be given to the nutritive evaluation of harvested forages, both hay and silage. Results of investigations on stage of maturity, harvesting methods, varieties of forages, fertilizer practices, climatic factors, and others point up the need to graze and to harvest forages at an early stage of maturity to obtain high digestibility and consumption of dry matter. Some data indicate that the digestibility of grasses and legumes within a given area can be predicted by the date of cutting. Similarly good predictions can be made on pasturage. Application of such information will have far-reaching value in rationing of livestock because more judicious and economical use of supplemental feeds will be possible.

There has been an increasing trend toward the use of digestible energy as a measure of the nutritive value of feeds rather than total digestible nutrients. This procedure requires the use of a bomb calorimeter in the laboratory and numerous institutions have added such facilities. Impetus to the trend was provided in 1955 by a recommendation of a technical committee of forage research specialists in the Northeastern States to adopt digestible energy as a standard measure of nutritive value.

It is noteworthy that a new, up-to-date energy laboratory has been developed at the Department of Agriculture's Research Center at Beltsville, Maryland, for use primarily with dairy cattle. The purpose is to investigate the fundamentals of energy metabolism and to evaluate feeds, especially forages, on a net energy basis. The laboratory is equipped with six metabolism chambers having numerous automatic measuring devices and controls. Active research work has been undertaken only in recent months.

The emphasis on production of meat, milk, and eggs during World War II gave a significant emphasis on feed processing which has continued ever since. There has been a large increase in the proportion of prepared or mixed feed to the total feed used in feeding livestock. While the proportion for poultry is highest, that for swine and dairy cattle represent tremendous tonnages. Special concentrate mixtures for beef cattle, especially fattening stock, also represent large tonnages.

Significant also is the trend toward the pelleting of single feeds and of commercial concentrate mixtures. This increases the ease of handling, prevents separation of ingredients, decreases the dust hazard and objection, and improves acceptability and efficiency of feed use by the animals. Experimentation and adoption to practice have been applicable to all classes of livestock. Results of lamb fattening trials show that pelleting of complete diets have promoted increased gains and improved feed efficiency. The New Mexico Agricultural Experiment Station found that higher ratios of hay or roughage to concentrate could be used in pellet form than is practical in ordinary feed lot practices. These results have been confirmed at the Federal Agricultural Research Center and at other State experiment stations. Chopping of hay and at least mixing with the concentrate portion of the ration has been found advantageous in beef cattle fattening with possibly some added advantages when pelleted also. Besides the practice of pelleting complete mixed diets that included roughages, the pelleting of protein-mineral-vitamin-feed adjunct mixtures for cattle, sheep, and swine is widespread. The pelleting of feeds seems to be economically sound in areas where

feed processing equipment is readily available on a large scale basis. There is research interest at present in the possibilities of field pelleting of hay into moderate sized briquettes perhaps two to three inches in diameter. If the dehydration and other developmental problems can be solved, such pelleting offers possibilities of increased ease of handling and decreased space required for storage.

In the area of changes in milling operations, that involved in the reduction in gossypol content in the manufacture of cottonseed meal is of chief interest. Gossypol is a compound naturally contained in cottonseed that has limited the use of cottonseed meal in diets of poultry and swine because of its toxic effects. Progress in lowering the free gossypol content through manufacturing improvements has been of material help. In addition, nutritional studies by the Federal Agricultural Research Service and the Texas Agricultural Experiment Station have shown that the fortification of the swine diet containing cottonseed meal with some additional high quality protein permits the presence of more free gossypol than would otherwise be the case. Thus greater use can be made of cottonseed meal in feeding swine and poultry than has been possible in the past.

Among the newer feed products, the continued extensive and in some cases expanded uses of urea, surplus fats, molasses, mineral mixtures, vitamin concentrates, and amino acids deserve mention. Considerable urea is being used in commercially mixed protein supplements and in concentrate mixtures for cattle and sheep. Definite limitation standards covering safeguards against toxic manifestations as well as effective utilization for protein replacements continue in effect.

The use of surplus fats, from both animal and plant sources, continues as an important segment of the feed industry. Fats are effective in reduction of the dust hazard as well as improvement of palatability and addition of energy to the diet. The molasses, mineral, vitamin, and protein usage in feeding practice is carried out in various ways. Usually they are governed by nutrient requirement standards for specific functions and classes of animals. Molasses and mineral supplement mixtures find usage, for example, in the nutrition of herbivora fed on low grade roughages to improve the functioning of the microflora of the rumen in aiding the utilization of the ration. Correction of the better known nutritional disorders where the nutrient requirements are well established has been largely achieved through usage of the mineral protein and vitamin supplements.

Recent years have seen a remarkable growth in the use of feed adjuncts such as antibiotics, hormones, arsenicals, and others. The place of the antibiotics has been fairly well established except that the search for new and alternative antibiotics and of the effectiveness of combinations of antibiotics, hormones, and other feed adjuncts continues to occupy the attention of research workers and feed manufacturers.

The use of antibiotics such as Aureomycin, penicillin, terramycin, and others in swine diets is now well accepted and widespread. This is especially true in the feeding of the growing and fattening pigs. Recently

hygromycin has claimed interest both for growth stimulation and as an anthelmintic. Aureomycin is being used in commercially mixed feeds for young dairy calves. The growth rate is stimulated from 10 to 30 percent during the first 16 weeks of life, with most of the stimulus occurring before the calves are 8 weeks old. The use of the antibiotic appears to reduce the incidence of scours and increases the feed efficiency and the general well-being of the animal. Intakes of 15 - 20 mg. daily per 100 pounds of body weight are recommended. For feeder lambs, antibiotic supplementation has given promising results as an aid in the control of enterotoxemia when high concentrate diets are fed. On high roughage diets the rate of gain and feed efficiency have been reduced, however.

It is now common practice to add stilbestrol to the ration or to use the implant procedure in the fattening of beef cattle. Experiments have demonstrated that the use of stilbestrol increases the rate of gain and the feed efficiency without adversely affecting the quality of the meat. There is also some interest in the use of stilbestrol for cattle on range or pasture that are to be finished for slaughter. For feeder lambs, the use of stilbestrol has given conflicting results with the disadvantages probably outweighing the advantages. Work is continuing on the use of sex hormones in swine feeding but the advantages have not been clear cut or fully apparent. Much of the effort is toward limiting the fatness of swine intended for market. Stilbestrol and other sex hormones are not recommended for breeding herds and flocks.

There has been a redevelopment of interest in the use of thyroprotein (or thyroxine) for stimulating milk production in dairy cattle. It appears that the feeding of thyroprotein and extra concentrates for short periods of 60 to 100 days to well-fed and well-managed cows may prove to be profitable under special conditions. However, if the extra concentrate is fed without the thyroprotein much the same total amount of milk for the lactation period will be produced. The feeding of thyroprotein by the general dairy farmer is not being recommended.

Among the other feed adjuncts, organic arsenicals are used to some extent in poultry and to a less extent in swine feeding. Recently there has been wide research interest in the use of tranquilizers in livestock feeding. Little has been published thus far and it remains to be seen whether such use will be made beyond strictly prophypactic purposes. The whole field of feed adjuncts claims wide research interest. It is likely that numerous new products will make their appearance.

Numerous problems of nutritional deficiency and disturbed or abnormal metabolism continue to engage the attention of the livestock industry. In most cases, research workers have supplied a better understanding of the causes and conditions of the disorders but no major solutions have been supplied in the past few years.

Bloat in cattle and sheep is mainly a disorder that occurs on legume pastures although some losses occur in the feed lot. Research work is being conducted in at least a dozen States plus the Department of Agriculture. There is increased emphasis in basic research on the physiology of

eructation, the microbiology of the rumen, the biochemistry of plant feeds associated with bloat and on the pathology involved in the deaths of bloated animals. The pathogenesis of bloat is obviously complex. Although an ideal bloat preventive has not been found, the use of emulsified oils in New Zealand, Canada, and some areas in the United States has afforded a marked degree of protection. One procedure has been the spraying of oil on the legume pasture just previous to grazing. The administration of penicillin to the grazing animal has been quite successful in certain areas but of limited value in others.

Grass tetany occurs in various forms and under various conditions and circumstances in the United States. The disorder appears sometimes on winter wheat or oats pasture and at other times on permanent grass pastures usually in the early Spring. It appears that it may be occurring with increasing frequency and in more areas than at first supposed. There is evidence that it is associated somehow with mineral imbalance or disturbance either in the plant or the animal. Affected animals ordinarily respond to calcium gluconate therapy but remedial prevention measures have failed thus far.

Urinary calculi continue to cause losses in cattle and sheep, especially in the feed lot in steers and in wether lambs. It appears that the disorder may arise from a number of causes, including necrotic tissue, infections and crystalline material in the kidneys. Minerals deposit on these centers or foci and stones form. Research efforts to lessen or eliminate infections and particularly to decrease the deposition of mineral salts through the use of acidic supplements and of the enzyme, hyaluronidase, have been partially successful.

Muscular dystrophy has been observed in several Rocky Mountain States in calves and lambs where the dams have been wintered on forage without concentrates. Analysis of the forages indicates an adequate tocopherol intake according to present information on requirements, although added tocopherol will prevent the muscular dystrophy. This would indicate that factors other than tocopherol deficiency are responsible for the muscular deficiency. The Oregon Agricultural Experiment Station has published evidence that a very wide calcium to phosphorus ratio in the ration of cows produced calves showing the disorder.

Ketosis or acetonemia is the result of a metabolic upset in which the animal fails to maintain the proper sugar level in the blood stream, probably brought about by the stress of calving and the inception of lactation. Most cases can be cured with one injection of 1.5 grams of cortisone. Larger doses produce an even more rapid cure. Even the most difficult cases have been cured quickly by an initial injection of 1.5 grams of cortisone followed by an additional injection of one gram on the third day, and in some cases, a third injection on the fifth day. Other related products have also been effective such as adrenocorticotropin (ACTH). Other experiments have shown that the feeding of sodium acetate and sodium propionate have been effective in prevention and curing the condition, but not as effective as a curative as the cortisone treatment.

The Soil, Plant and Nutrition Laboratory, located at Ithaca, New York, a Federal research unit of the Soil and Water Conservation Research Division of the Agricultural Research Service, has continued studies on a number of livestock abnormality problems with cooperation of various agencies. These are national or regional problems although they are generally recognized as local area disorders. They are frequently associated with mineral imbalances set up by unusual soil, plant, and environmental interrelations. Some of the simpler yet very important mineral-induced disorders that have been discussed at earlier conferences involve fluorine, selenium, phosphorus, cobalt, copper, and molybdenum. Further progress has been made in mapping the areas of the United States where these disorders are serious factors.

Some new light has been thrown on the interrelationships of copper, molybdenum, and sulfur. Molybdenum seems to be antagonistic toward the metabolism of copper and this reaction is accentuated by the sulfur radical. Quantitative data on the safe levels and proportions of the three substances need to be determined more exactly as well as better means of identifying the effects in questionable areas and animals.

A serious disorder that occurs in some areas of the Western States is known as brisket disease. Affected animals show enlargement of the heart, fibrosis of the liver and accumulation of fluids in body cavities along with swelling of the brisket. Animals show poor condition and high death rate. Altitude of the range seems to be a factor. It appears that some abnormality in plant growth and composition must be involved. The problem still awaits solution.

Other small-area problems scattered over the Western States involve congenital abnormalities. The indications are that some peculiar soil or plant conditions are responsible rather than hereditary factors in the animals. Some of these abnormalities involve skeletal deformities such as crooked legs, wryneck and humped spine that suggest faulty metabolism during fetal development. "Monkey Face" in lambs is associated with delayed birth with consequent enlargement of the fetus. With failure of normal birth, the ewes are lost. History of the trouble on some restricted areas has been traced back 50 years. Avoidance of the use of these trouble areas is necessary until the causes and prevention of trouble are established.

Collectively, these unsolved problems represent a significant economic loss to the cattle and sheep industry.

The improvements in livestock feeding and nutrition, as sketched in the foregoing, have been reflected in a continued increase in efficiency of feed conversion into live weight gains and milk and meat production. Some of this increase must be credited to advances in breeding, management, and disease control. For example, pigs from meat-type strains on performance tests have shown a gain of 100 pounds on 300 pounds of feed, whereas 400 pounds of feed were considered excellent 20 years ago. In the case of beef cattle, the improvement approaches 12 percent. The improvements just noted have their counterparts in the other species as well.

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